

# Catalog of Isolated Galaxies Selected from the 2MASS Survey

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We search for isolated galaxies based on the automatic identification of isolated sources from the Two Micron All-Sky Survey (2MASS) followed by a visual inspection of their surroundings. We use the modified Karachentseva criterion to compile a catalog of 3227 isolated galaxies (2MIG), which contains 6% of 2MASS Extended Sources Catalog (or 2MASX) sources brighter than  $K_s = 12^m$  with angular diameters  $a_K \geq 30''$ . The catalog covers the entire sky and has an effective depth of  $z \sim 0.02$ . The 2493 very isolated objects of the catalog, which we include into the 2MVIG catalog, can be used as a reference sample to investigate the effects of the environment on the structure and evolution of galaxies located in regions with extremely low density of matter.

## 1. INTRODUCTION

Current observational data about the distribution of galaxies demonstrate the existence of large-scale cosmic structures consisting of filaments, walls, and clusters bordering empty volumes of space (voids). Such a cellular structure can be naturally explained in terms of the standard  $\Lambda$ CDM cosmological model. About 5–10% of all galaxies reside in dense (virialized) cluster regions, and about the same number is found in the nonvirialized neighborhoods of these clusters. Most of the galaxies are located in sparsely populated isolated systems resembling the Local Group (50%) or in low-density clouds (25%) of which the closest to us is Canes Venatici I. The remaining 5–10% of galaxies are scattered in the general metagalactic field. Note that the estimate of the fraction of “truly isolated” galaxies still remains a topic of debate.

Isolated galaxies are objects that have not been appreciably affected by their closest neighbors over the past 1–2 Gyr. This means that their physical properties are determined mostly by the initial formation conditions and internal evolutionary processes. A representative sample of isolated galaxies is needed to test models of

the formation and evolution of galaxies, and as a reference sample for the studies of the properties of galaxies in pairs, groups, and clusters in order to understand the effects of the environment on such fundamental galactic properties as morphology, gas and dust content, chemical composition, and star-formation rate.

No catalog of isolated galaxies can be perfect. Our catalog, which is a magnitude- and angular-diameter limited sample of galaxies, does not include dwarf objects in distant volumes, and some spatially isolated galaxies may have close projected neighbors. On the other hand, such samples usually contain a certain fraction of false isolated galaxies. When compiling a sample of isolated galaxies every effort should be made to minimize these statistical errors. At the same time, the sample should be representative, i.e., it must cover a significant fraction of the sky and be sufficiently deep.

The Catalog of Isolated Galaxies (known in Russian by its initials KIG) [1] is an example of a successful attempt to compile such a sample. It is based on the following empirical criteria used to select isolated objects:

$$X_{1i}/a_i \geq s = 20, \quad (1)$$

$$4 \geq a_i/a_1 \geq 1/4, \quad (2) \quad 2. \quad \text{SEARCH FOR ISOLATED GALAXIES IN THE 2MASS SURVEY}$$

where subscripts “1” and “ $i$ ” refer to the fixed galaxy and its neighbors, respectively. According to these criteria, a galaxy with a standard angular diameter  $a_1$  is considered isolated if its angular separation  $X_{1i}$  from all its neighbors with “significant” angular diameters  $a_i$  inside interval (2) is equal to or exceeds  $20a_i$ . Criteria (1)–(2) were applied to 27 840 galaxies of the CGCG catalog [2], which contains northern-sky galaxies with photographic magnitudes  $m_p < 15.7^m$ . As a result of visual inspection of these galaxies and their surroundings in DSS-1 images, a total of 1050 galaxies at Galactic latitudes  $|b| \geq 20^\circ$ , or 4% of all CGCG galaxies were found to meet the adopted isolation criterion.

The long-term AMIGA project (<http://www.iaa.es/AMIGA.html/>) has been carried out since early 2000 by an international team from Spain, the United States, France, Italy, and Germany. The aim of this project is to study the physical properties of the most isolated galaxies of the KIG and, especially, the properties of the interstellar medium in these galaxies taking into account the observational data that became available in recent years. In the course of these studies the isolation criterion was tested and had its efficiency confirmed for most of the KIG galaxies.

In recent years, attempts have been made to compile new catalogs of isolated galaxies based, in particular, on the SDSS survey [3]. However, so far these samples cover only a small fraction of the sky.

In this paper we report a new catalog of isolated galaxies, designated 2MIG, where we use the advantages offered by the photometrically homogeneous 2MASS survey covering the entire Northern and Southern hemispheres.

The Two Micron All-Sky Survey (2MASS) [4] was made in three infrared photometric bands,  $J$  (1.11–1.36  $\mu\text{m}$ ),  $H$  (1.50–1.80  $\mu\text{m}$ ), and  $K_s$  (2.00–2.32  $\mu\text{m}$ ). It contains about 2.6 million extended sources with  $K_s$ -band magnitudes brighter than  $14.5^m$ . As a result of this survey a total of 1.64 million galaxies with  $K_s \leq 14.5^m$  and angular diameters greater than  $10''$  have been identified, which now constitute the 2MASS Extended Sources Catalog (XSC) [5]. For the 2MASS XSC objects, a large number of structural and photometric parameters are listed, which have been determined using homogeneous procedures, and that explains why 2MASS XSC was used to create a number of new catalogs, e.g., the 2MFGC catalog of flat galaxies [6].

We identified isolated galaxies by applying slightly modified criteria (1) and (2) to the objects of the XSC 2MASS catalog. We increased to  $s = 30$  the dimensionless “distance”  $X_{1i}/a_i = X_{1i}/2r_i$  to the neighboring object in criterion (1), as the infrared diameters of galaxies in the 2MASS are systematically smaller than their standard optical diameters [7]. Thus we found that the median standard blue to infrared diameter ratio for RFGC [8] galaxies was  $a_{25}/2r_{20fe} = 1.5$  and it differed widely for galaxies of different structures [9]. For example, we consider galaxy “1” with a  $K$ -band magnitude  $K_{20fe} \equiv K_s$  and isophotal  $K$ -diameter  $a_K \equiv 2r_{20fe}$  to be isolated if conditions (1) and (2) are fulfilled for this galaxy and any of its significant neighbors for  $s = 30$ . When testing the isolation of a galaxy with respect to its possible faint companions, we apply the algorithm of isolated galaxy identification to all candidate galaxies with apparent  $K_s$ -band magnitudes in the interval

$$4.0^m < K_s \leq 12.0^m \quad (3)$$

and angular diameters

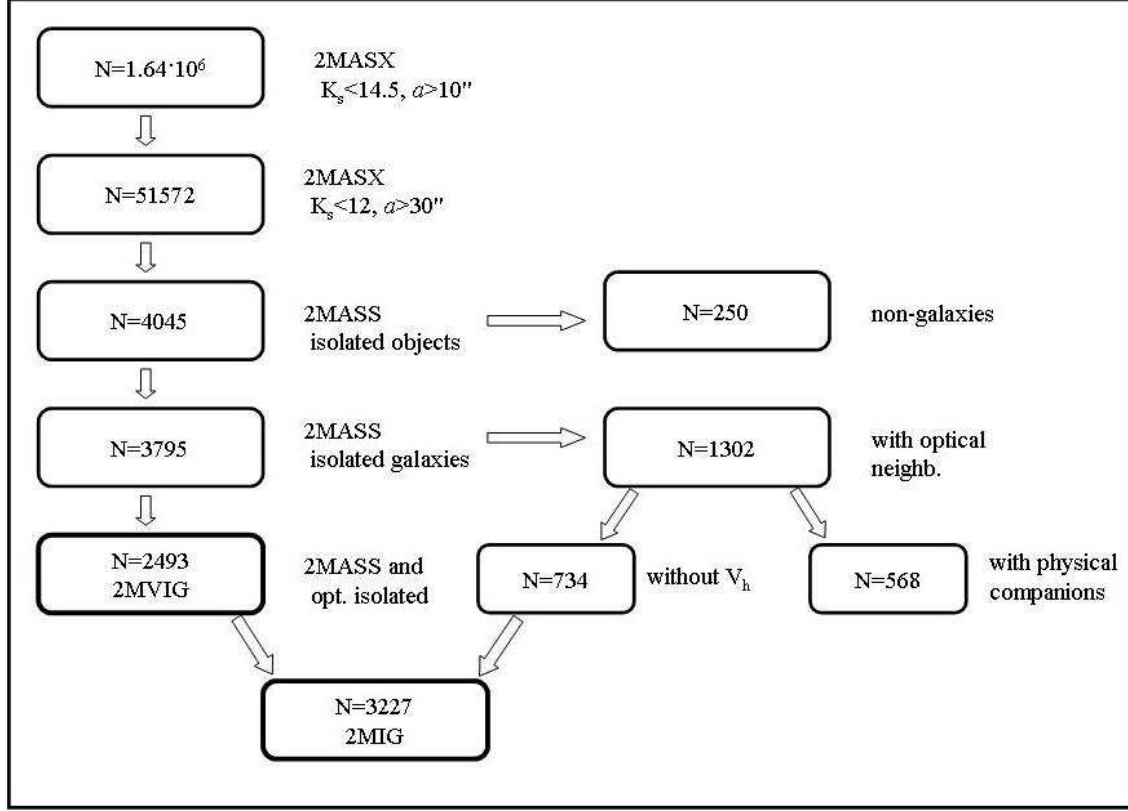
$$a_K \geq 30''. \quad (4)$$

We chose the limiting apparent magnitude  $K_s = 12.0^m$  so as to make it consistent with the limiting magnitude of the KIG for galaxies with typical color indices  $B - K_s = 3.5^m - 4.0^m$ . Note that below the  $K_s = 12.0^m$  limit and down to the 2MASS limiting magnitude there remain many faint galaxies with  $K_s = 12.0^m - 14.5^m$ , which we use in the test for isolation. The bright-end magnitude constraint is due to the specifics of the 2MASS photometry of the most extended bright galaxies [5]. The 2MASS XSC catalog does not include objects with angular diameters  $a_K = 2r_{20fe} < 10''$ , and therefore for the condition (2) to be fulfilled near its lower limit, we also had to limit the angular diameters of potential isolated galaxy candidates. We set the minimum diameter equal to  $30''$ , so that our sample would remain sufficiently representative, although conditions (2) and (4) become somewhat inconsistent for galaxies with small diameters  $a_K = 30'' - 40''$ .

We performed an automatic identification of isolated galaxies using the Pleinpot software package (<http://leda.univ-lyon1.fr/pleinpot/> / [pleinpot.html](http://pleinpot.html)) developed for the reduction and analysis of astronomical data. For each object and its nearest neighbor from the 2MASX we fix the coordinates,  $K_s$ -band magnitudes, and  $a_K/2$  radii. All neighbors with significant sizes located in the  $31^\circ \times 31^\circ$  area centered on each of the 51572 candidate isolated galaxies were identified, and the mutual distances between the fixed and neighboring galaxies were found. Significant neighbors of the galaxy considered were then ranked by the dimensionless distance  $s$ . For a galaxy to be classified as isolated its dimensionless distance from all the significant neighbors must exceed  $s = 30$ . We chose the above areas with a  $1^\circ$  overlap and identified and excluded all the shared galaxies found at the boundaries between the adjacent areas. An automatic algorithm produced a sample of 4045 objects, which we then subjected to a visual inspection.

Near-infrared photometry is superior to optical surveys in that it is affected only slightly by the galactic extinction. The major disadvantage of the 2MASS survey is short exposure time (about 7 s/object), which made the survey insensitive to low surface brightness objects, especially to those of blue color. As a result, many dwarf irregulars are unrepresented in the 2MASS survey and this may seriously affect the decision whether a particular galaxy is isolated or not. That is why at the second stage of our work we visually inspected the neighborhood of each of the 4045 selected galaxies on the DSS-1 and DSS-2 images, paying special attention to those objects that are absent from the 2MASS.

At first we identified among the 4045 extended objects those that we found not to be galaxies, but rather planetary nebulae, star clusters, or multiple stars ( $N = 250$ ). We excluded these objects from further analysis. We then selected in DSS-1 a  $20' \times 20'$  to  $60' \times 60'$  wide area (depending on the diameter  $a_1$ ) around each of the remaining 3795 galaxies, measured the optical angular diameters of the neighboring galaxies in this area, and marked all the significant members according to Karachentseva's criterion (1) and (2). We considered a galaxy to be "very isolated" if the inspection of its neighborhood revealed no significant neighbors either in the infrared or at optical wavelengths. As a result, we found a total of 2493 such "2MASS Very Isolated Galaxies" (2MVIG), which make up a total of 4.8% of all galaxies brighter than  $K_s = 12.0^m$  with diameters  $a_K \geq 30''$ . If we found the candidate galaxy to have significant neighbors in optical images, we additionally checked their radial velocities using the LEDA and NED databases and the catalogs of the pairs and groups of galaxies [10, 11]. A total of 568 of the 1302 galaxies with one or several significant neighbors found on DSS images have neighbors with radial velocities close to that of the candidate galaxy ( $\Delta V_h < 500$  km/s). No radial velocity measurements are available for the significant projected members of the remaining 734 candidate isolated



**Figure 1.** Selection of isolated galaxies.

galaxies. A considerable part of these objects may eventually make it into the list of truly isolated galaxies. We came to this conclusion after comparing the radial velocities of the galaxy and of its nearest neighbor and after analyzing the results of our radial velocity measurements of the neighbors of isolated galaxies in the Local Supercluster [12]. We refer to the combined sample of these 734 galaxies and 2493 2MVIG galaxies as the 2MASS Isolated Galaxies Catalog, or 2MIG. Figure 1 shows schematically the procedure of creating the 2MIG and 2MVIG samples. Figures 2a–2e present examples of isolated galaxies identified in the 2MASS and located in different environments. The images are extracted from the DSS-1 survey. The areas have a size of  $20' \times 20'$ : North is at the top and East on the left. Candidate isolated galaxies are located at the center, and their neighbors are marked by the arrows. Let us now give brief comments on

various situations found as a result of the optical inspection of the candidate isolated galaxies. Figure 2a: the galaxy has no significant neighbors neither in the 2MASS nor in the DSS survey. In Fig. 2b: the neighboring galaxy does not show up in the 2MASS, but is significant in the DSS. According to the quoted radial velocities, it is a foreground galaxy with no effect on the isolation of the candidate galaxy<sup>1</sup>. Figure 2c: the neighboring galaxy cannot be seen in the 2MASS, but is significant in the DSS. We exclude the tested

<sup>1</sup> The 2MIG 938 galaxy belongs to this group. Formally its nearest neighbor from the 2MASX list is located at a distance of  $2s = 65$ . However, visual inspection reveals another galaxy—KPG 123A—to be in contact with KPG 123B. KPG 123A has a similar optical size and has been detected as a low surface brightness infrared source in 2MASXi. Given that the radial velocities of these galaxies differ by 900 km/s or 700 km/s according to the NED and LEDA, respectively, we can consider KPG 123B to be an isolated galaxy.

galaxy from the list of isolated galaxies because the two objects have close radial velocities. Figure 2d: the neighboring galaxies that are significant in optical images have no radial velocity estimates available. In these cases we considered the candidate galaxy as possibly isolated.

Lastly we should mention a special case, where a 2MASX galaxy has no significant members, but has dwarf objects found in its vicinity, which, albeit “insignificant” according to the criterion (1)–(2), have radial velocities close to that of the galaxy considered. Figure 2e shows an example of such a system (note that the field contains other bluish objects with no radial velocity measurements). We formally consider such galaxies to be isolated. Systems consisting of a solitary galaxy surrounded by dwarf companions exclusively are by themselves of considerable interest from the viewpoint of their occurrence and dynamical evolution. “Insignificant” companions with close radial velocities have been found for 5% of the galaxies included into the 2MVG catalog.

### 3. 2MIG CATALOG OF ISOLATED GALAXIES

Based on the above considerations, we make our combined 2MIG catalog of isolated galaxies (which is partly listed in the Table) of a total of 3227 objects including the 2MVG sample of 2493 among most isolated galaxies. The electronic version of the catalog is available at <ftp://cdsarc.u-strasbg.fr/pub/cats/VII/257>.

The columns of the Table give:

- (1) the running number of the object in the 2MIG catalog;
- (2) the 2MASS equatorial coordinates for J2000.0 epoch;
- (3) name of the galaxy according to the NED database. If the galaxy could not be identified in the known catalogs, we list it in column (3) as a 2MASX source with the corresponding co-

ordinates in column (2) or under a PGC number from the LEDA database;

- (4)  $r_{20fe}$  is angular radius (semimajor axis) in arcsec;

- (5)  $K_s$  is the 2MASS magnitude corresponding to the  $K_{20fe}$  isophote;

- (6)  $2s = X_{1i}/r_i$  is a dimensionless “distance” between the isolated galaxy and its nearest significant neighbor;

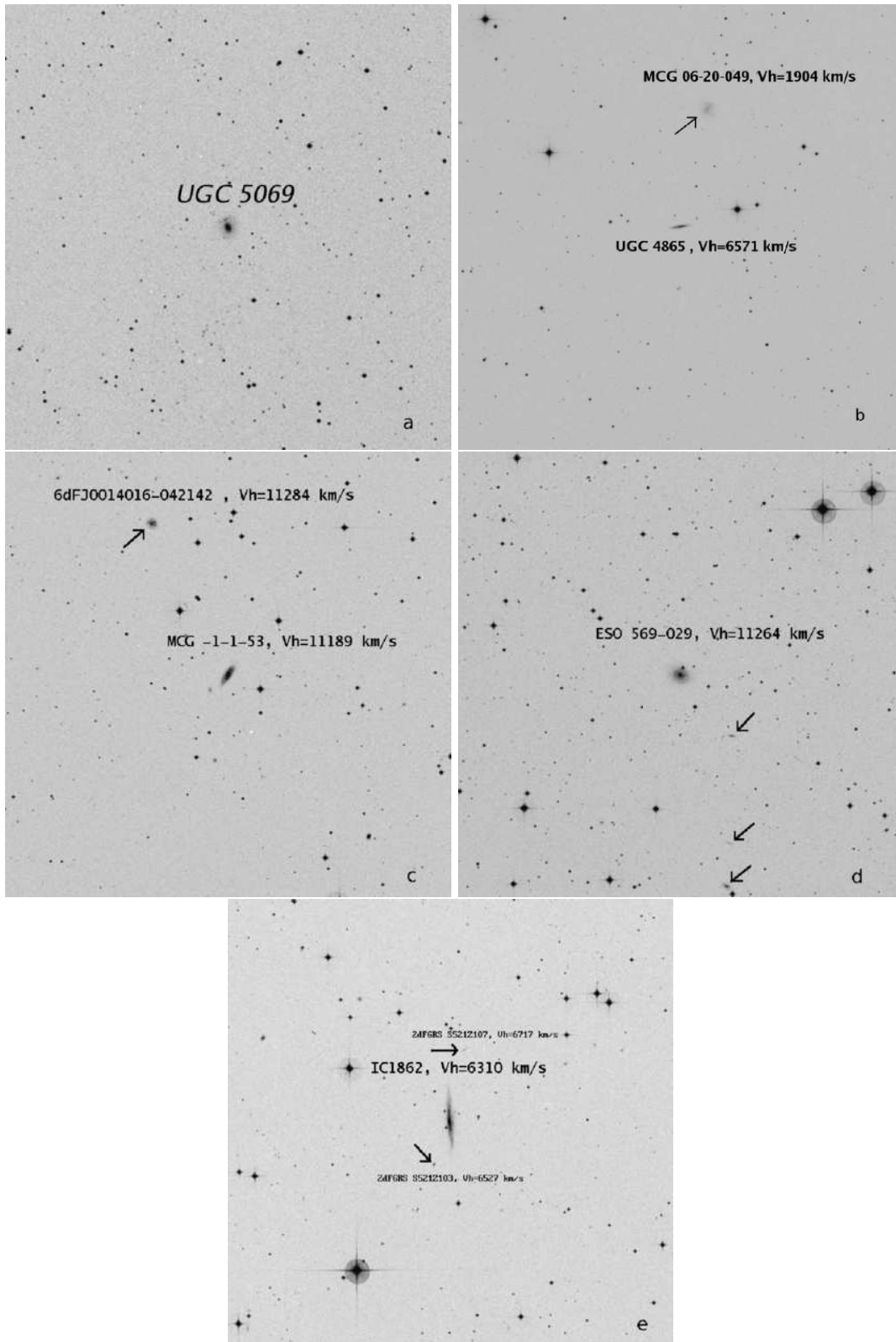
- (7) heliocentric radial velocity (in km/s) adopted from the LEDA or NED database. A total of 2328 (72%) and 1775 (71%) galaxies in the 2MIG and 2MVG catalogs, respectively, have measured radial velocities;

- (8) morphological type encoded in the de Vaucouleurs scale. We visually estimated the morphological types of the catalog galaxies by inspecting their images in the DSS-1, DSS-2, and SDSS optical surveys and the 2MASS *JHK*-band images of the central parts of the galaxies. Morphological types could be determined with less certainty in the zone of strong extinction at low Galactic latitudes  $|b| < 10^\circ$ . We adopted the same  $T = -2$  for the elliptical galaxies of all subclasses irrespective of their apparent ellipticity;

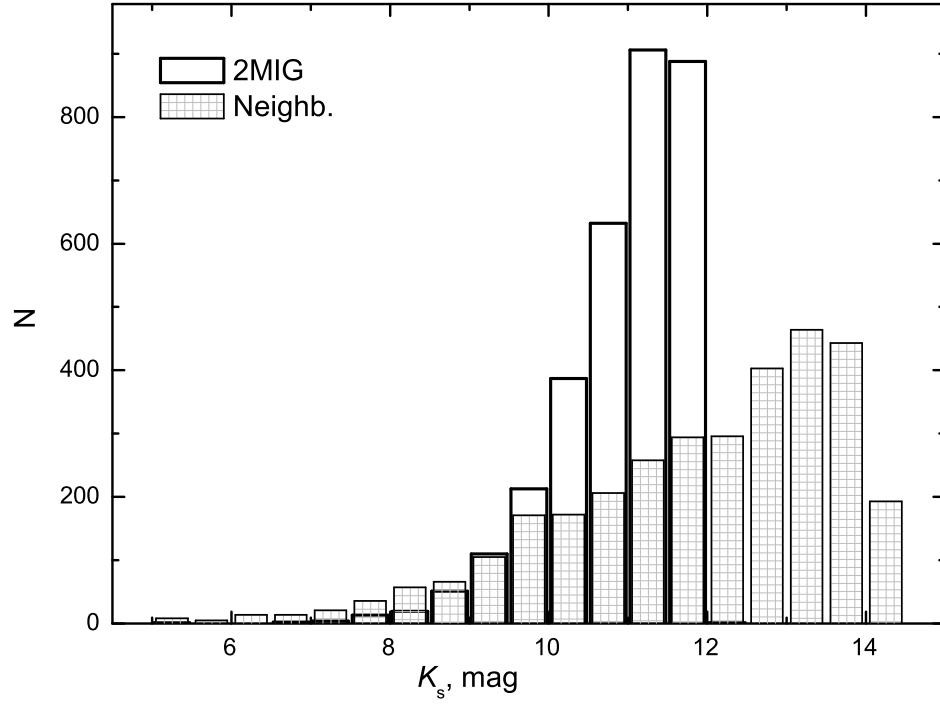
- (9) the number of significant neighbors of the isolated galaxy found as a result of further inspection of its vicinity on the DSS-1 images; the blanks correspond to 2MVG galaxies with no significant neighbors found on optical images;

- (10) comments on the morphological peculiarities of an isolated galaxy and its identification in the NED with the objects from the KIG, IRAS, and catalogs of active and peculiar galaxies (by Markarian, Arp and Madore, etc). The comments here as well indicate the presence of insignificant companions with close ( $\Delta V_h \leq 500$  km/s) radial velocities. Vc indicates a companion with velocity.

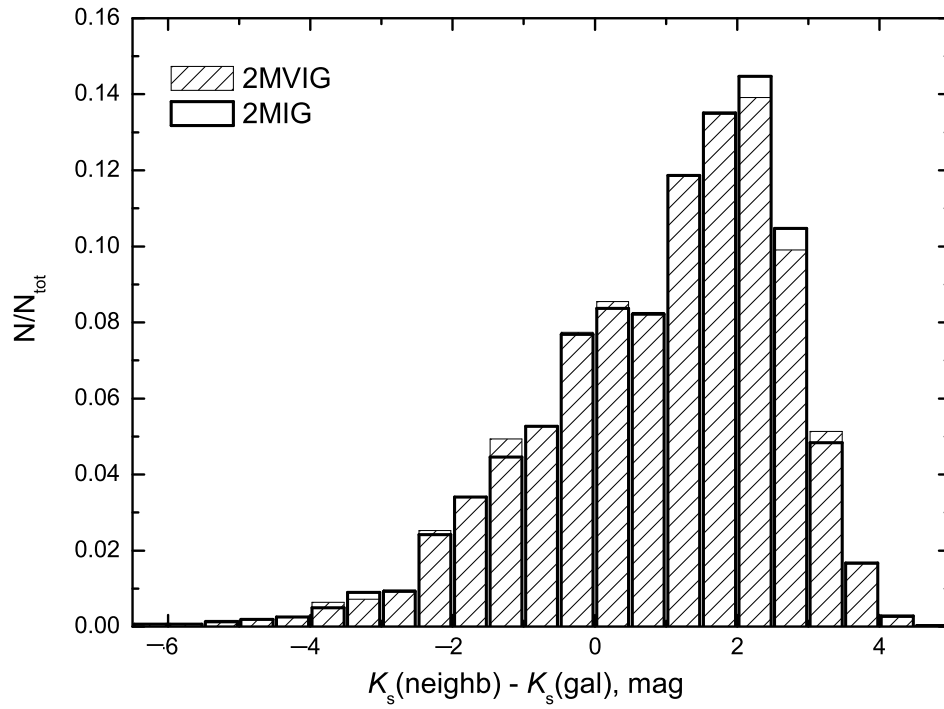
We identified a total of 244 KIG galaxies, 1053 infrared IRAS sources, and 94 galaxies from the catalogs and lists of active galaxies among the 2MIG objects. Among the 2MVG objects, we found a total of 227, 820, and 69 KIG galaxies, IRAS sources and active galaxies, respectively. A



**Figure 2.** Examples of isolated galaxies in different environments. The arrows indicate the neighboring galaxies.



**Figure 3.** Distribution of  $K_s$ -band magnitudes of 2MIG isolated galaxies and their closest neighbors.



**Figure 4.** Distribution of the "nearest significant neighbor vs. isolated galaxy" magnitude differences for 2MIG and 2MVG galaxies.

significant fraction of isolated galaxies exhibits such features as a bar, ring, or an asymmetric (peculiar) structure.

#### 4. 2MIG GALAXIES AND THEIR SIGNIFICANT NEIGHBORS

Let us now compare some parameters of isolated 2MIG galaxies and of their nearest significant neighbors found in the 2MASS XSC survey.

Figure 3 presents differential distributions of  $K_s$  magnitudes of the 2MIG isolated galaxies and their nearest significant neighbors. The mean apparent magnitude of the sample of isolated galaxies and its standard deviation are  $\langle K_s \rangle = 10.94^m$  and  $SD = 0.81^m$ , respectively. The corresponding parameters for the 2MVIG sample are almost the same and equal to  $10.90^m$  and  $0.84^m$ , respectively. Magnitude distributions of the nearest significant neighbors have an appreciably greater scatter and are shifted towards fainter objects:  $\langle K_s \rangle = 11.92^m$  and  $SD = 1.76^m$ .

Individual  $K_s$ -magnitude differences (Fig. 4) between isolated galaxies and their nearest neighbors are distributed asymmetrically in the  $[-5.5^m, +4.5^m]$  interval with a maximum near  $+2.0^m$ . About 1/3 of all 2MIG galaxies have significant members that are brighter than the isolated galaxies themselves.

Figure 5 demonstrates differential distributions of angular diameters  $a_K$  (in arcsec) of a number of isolated galaxies and their most significant neighbors. The minimum angular diameter condition imposed on the galaxies in the 2MASS XSC catalog  $(a_K)_{min} = 10''$  combined with condition (2) results in a formal requirement that only galaxies with diameters  $a_K > 40''$  can be viewed as candidate isolated galaxies. We imposed a softer constraint  $a_K \geq 30''$ . It is evident from the data shown in Fig. 5 that the use of the  $a_K > 40''$  constraint would result in loss of 1230 galaxies, which make up for 38% of our sample.

In Fig. 6 one can see the distribution of the dimensionless parameter  $2s$  for the nearest sig-

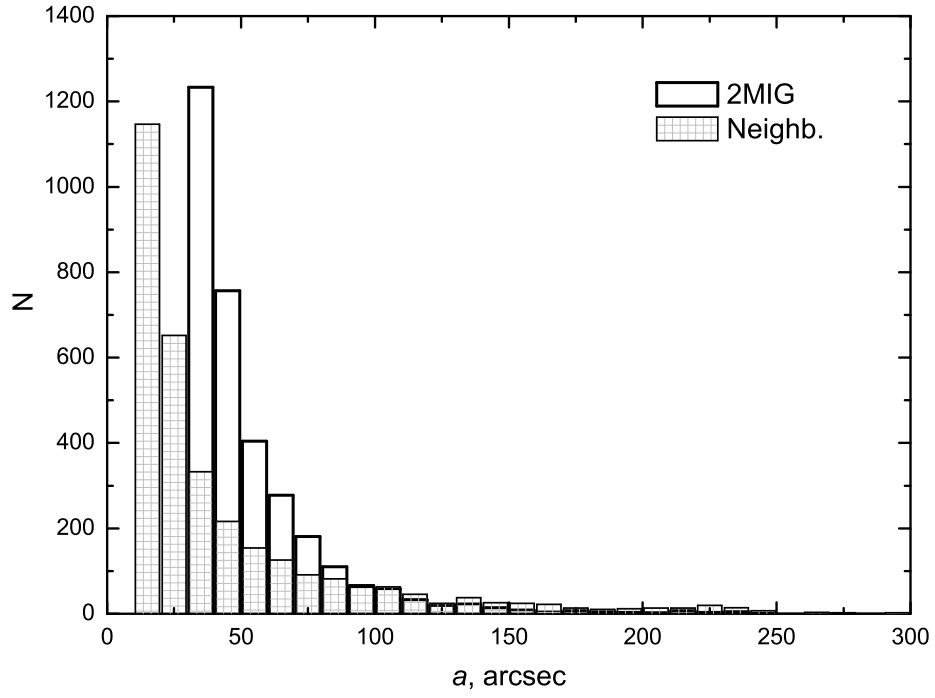
nificant neighbors of 3227 2MIG galaxies. The mean and the standard deviation of this parameter for the 2MIG galaxies are equal to  $\langle 2s \rangle = 81.1$  and  $SD = 21.3$ , and the corresponding values for the 2MVIG galaxies are equal to 81.9 and 21.8, respectively, i.e., differ insignificantly for the two samples considered.

#### 5. BASIC PROPERTIES OF 2MIG SAMPLE

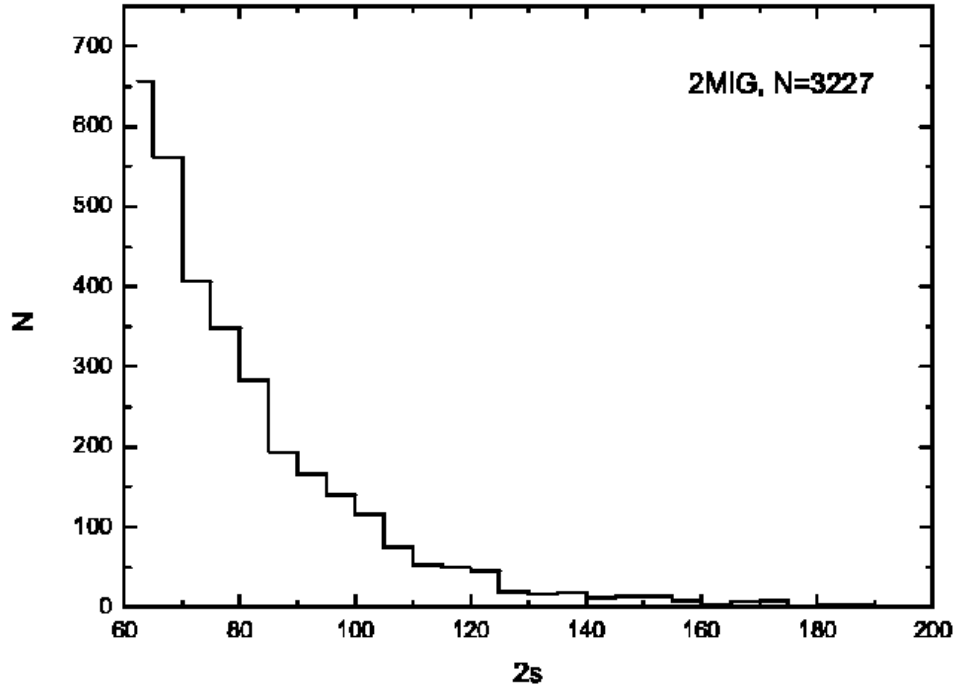
Figure 7 represents the relation between the apparent magnitude  $K_s$  and the logarithm of angular diameter  $a_K$  for 3227 2MIG-galaxies. It can be characterized by a direct regression line  $\langle K_s | a \rangle = -3.77 \log a + 17.29$  (the solid line) with a standard deviation of  $SD = 0.49^m$ ; the inverse regression  $\langle \log a | K_s \rangle = -0.17 K_s + 3.53$  is shown by the dotted line.

In Fig. 8 we demonstrate the cumulative distribution of apparent magnitude  $K_s$  for different samples: for all 1.65 million 2MASS XSC galaxies used in testing the isolation conditions (1); for 51572 galaxies brighter than  $K_s = 12.0^m$  with angular diameters  $a_K \geq 30''$ , which were tested for isolation (2); for 3227 2MIG galaxies with  $K_s < 12.0^m$  and  $a \geq 30''$  included into the catalog of isolated galaxies (3); for the 2493 most isolated galaxies of the 2MVIG sample (4). The two parallel lines correspond to the uniform distribution with a slope of  $0.6 K_s$ . It is evident from this figure that faint extended galaxies of the 2MASS survey follow the uniform distribution and their excess at the bright end ( $K_s < 9^m$ ) is due to the presence of the Local Supercluster. A comparison of distributions 1 and 2 leads us to conclude that imposing the constraint  $a_K \geq 30''$  on candidate isolated galaxies with  $K_s \leq 12^m$  reduces their number by about 40%. Isolated galaxies of the entire 2MIG catalog and the 2MVIG subsample agree well with the uniform distribution and demonstrate only a small deficit of isolated objects among bright galaxies (as expected due to the effect

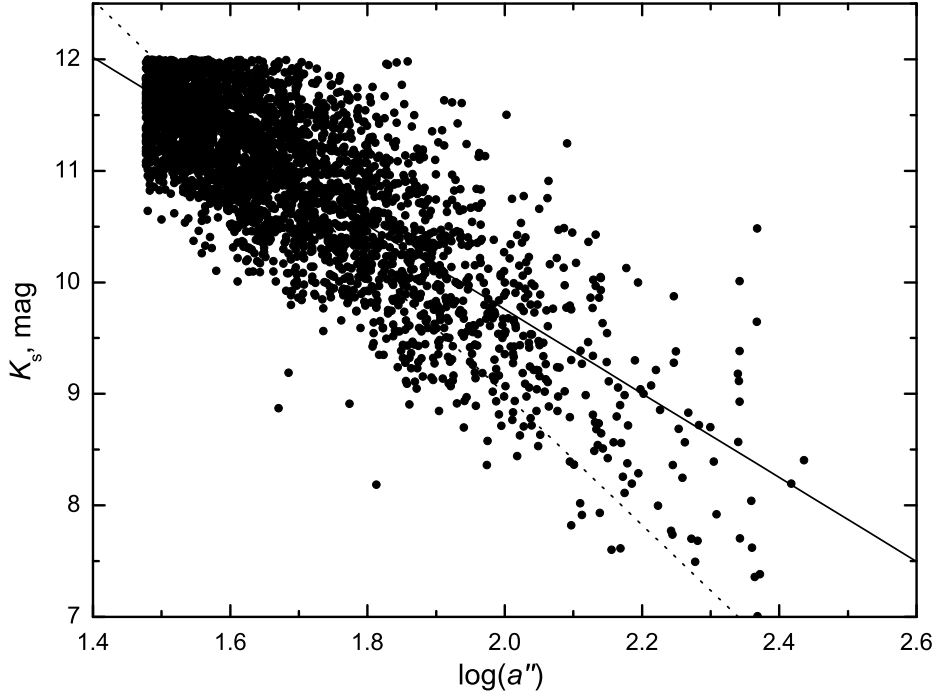




**Figure 5.** Angular diameter distributions of the 2MIG galaxies and their nearest significant neighbors.



**Figure 6.** Distribution of dimensionless parameter  $2s$  for the nearest neighbors of 3227 2MIG galaxies.



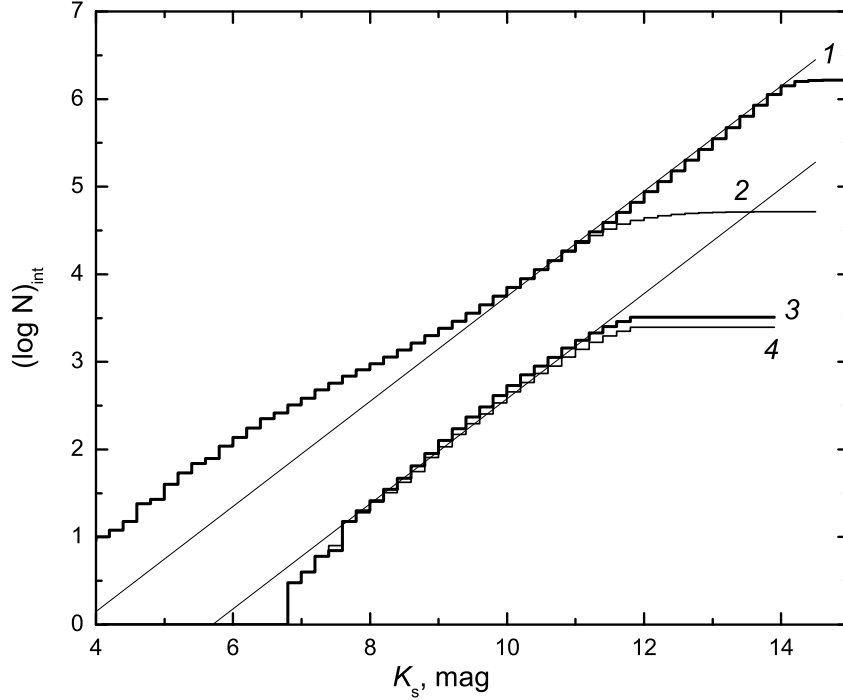
**Figure 7.** Relation between the apparent  $K$ -band magnitude and logarithm of angular diameter for 3227 galaxies of the 2MIG catalog. The solid and dashed lines show the “ $K_s$  vs.  $a$ ” and “ $a$  vs.  $K_s$ ” regressions, respectively.

of the Local Supercluster). Thus, our criterion identifies about the same fraction of isolated objects both among nearby and distant galaxies. Note that the sample of isolated galaxies identified in the SDSS survey [3] exhibits a strong dependence of a fraction of isolated galaxies on their apparent magnitude, i.e., it is subject to a significant selection effect.

Figure 9 shows the sky distribution of 2MIG galaxies in equatorial and Galactic coordinates. The distribution appears to be quite uniform with no appreciable excess or deficit of galaxies in the regions of the well-known Virgo, Fornax, or Coma clusters. The average number density of isolated galaxies is almost independent on the Galactic latitude, thereby corroborating the efficiency of the 2MASS survey, which depends only slightly on the Galactic absorption. However, the distribution of 2MIG galaxies exhibits voids and clumps in the direction towards the Galactic center (at Galactic longitudes  $l = \pm 30^\circ$  and latitudes  $b = \pm 7^\circ$ ), that are due to both inter-

stellar extinction and high density of stellar images, which sometimes form false 2MASS XSC sources mistaken for galaxies. For these reasons the region in the vicinity of the Milky Way center mentioned above should be excluded when performing a rigorous statistical analysis of the 2MIG catalog.

More than 70% of 2MIG galaxies have measured radial velocities. In Fig. 10 one can find the distribution of radial velocities of 2328 isolated galaxies of our catalog with respect to the centroid of the Local Group. The hatched area shows the distribution of 1775 galaxies of the 2MVIG subsample. The distribution peaks at 5000 km/s and the mean radial velocity is equal to 6570 and 6360 km/s for the 2MIG and 2MVIG catalogs, respectively. Thus, the characteristic depth of the new sample of isolated galaxies is about the same as that of the KIG catalog (6624 km/s [13]). Note that the mean radial velocity of the nearest significant members of 2MIG galaxies (12000 km/s) is almost twice as high as

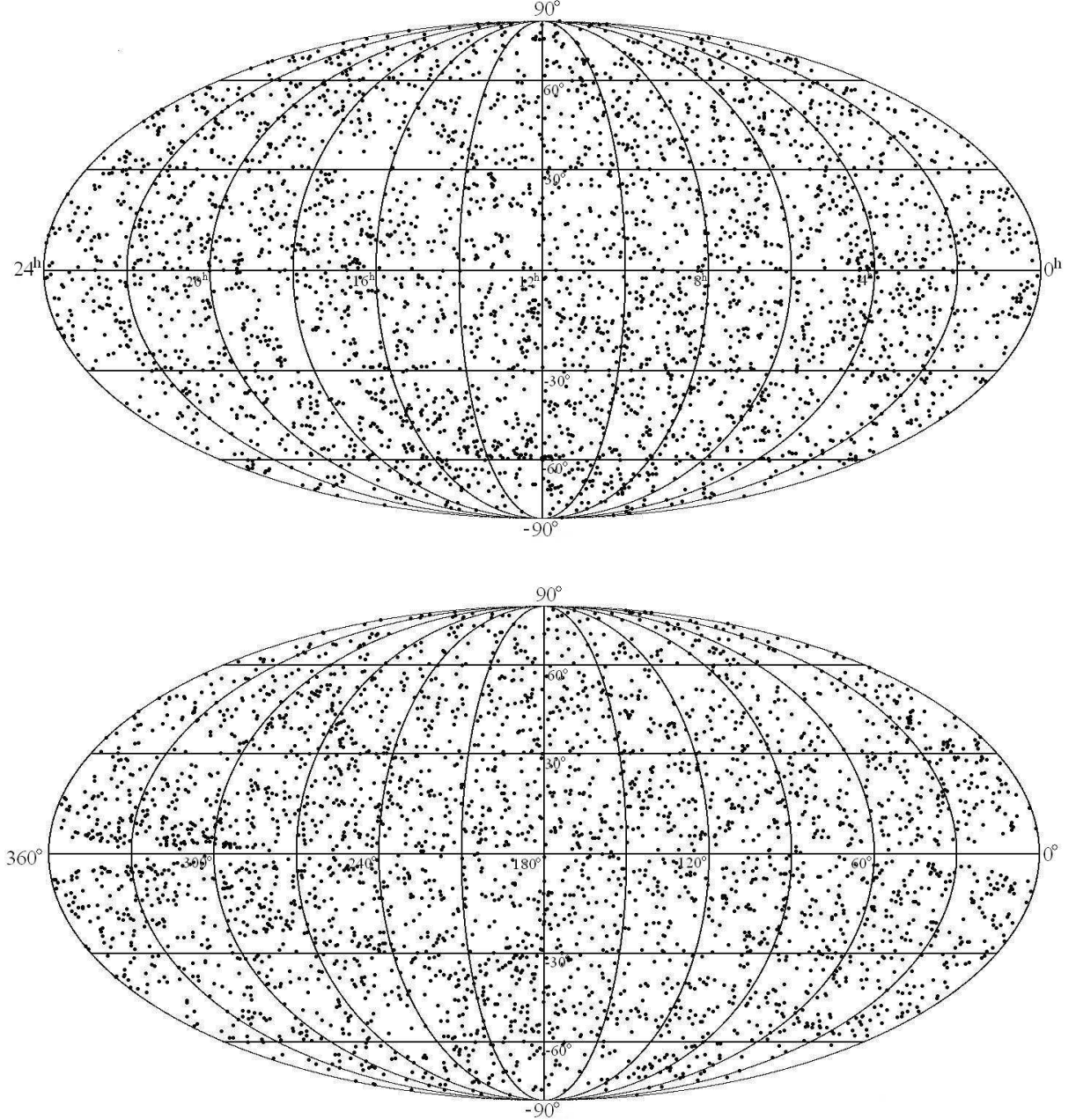


**Figure 8.** The “number of galaxies vs. apparent magnitude” relation for all 2MASS XSC galaxies ( $N = 1.6 \times 10^6$ ) (1); for the 2MASS XSC sample with  $K_s \leq 12^m$ ,  $a_K \geq 30''$  ( $N = 51572$ ) (2); for the 2MIG catalog of isolated galaxies ( $N = 3227$ ) (3), and for the 2MVIG sample of “truly” or “very isolated” galaxies ( $N = 2493$ ) (4). The straight lines correspond to the uniform distribution  $\log N(< K_s) \propto 0.6K$ .

the velocities of the isolated galaxies, i.e., most of the projected neighbors are background objects, which are unassociated with isolated galaxies.

The lower panel in Fig. 11 presents the distribution of the occurrence rates of 2MIG galaxies by morphological types. The hatched histogram shows the distribution of more isolated 2MVIG galaxies. The occurrence rates of different morphological types in the 2MIG and 2MVIG samples differ insignificantly. Elliptical and lenticular galaxies make up for about 19% of the sample, whereas the fraction of irregular galaxies ( $T = 9, 10$ ) does not exceed 1%. According to initial estimates [14], the fraction of E and S0 galaxies in the KIG is equal to 18%, which practically coincides with the fraction of these galaxies in the 2MIG catalog. The fraction of irregular galaxies in the KIG is equal to 10%, which is one order of magnitude higher than in the new catalog. Recently, Sulentic et al. [15] and Hernandez-Toledo et al. [16] revised the morphological types

of KIG galaxies using DSS-2 and SDSS images. According to the data of Hernandez-Toledo et al. [16], that we demonstrate in the upper panel of Fig. 11, E and S0-type galaxies make up for 16%, and irregular galaxies for 4% of all the KIG galaxies. It follows from the comparison of the upper and lower panels in Fig. 11 that the fraction of elliptical and lenticular galaxies in the 2MIG catalog is about the same as in the KIG, whereas the occurrence rate of early-type spirals (Sa, Sab) in the 2MIG catalog is appreciably higher than in the KIG. These differences appear quite expected given the low sensitivity of the infrared survey to blue extended structures of low surface brightness, which are typical of late-type galaxies. To assess the accuracy of the galaxy morphological type findings, we compared our estimates with the morphological types of 2907 2MIG galaxies given in the LEDA database. Figure 12 demonstrates the distribution of differences between the two independent

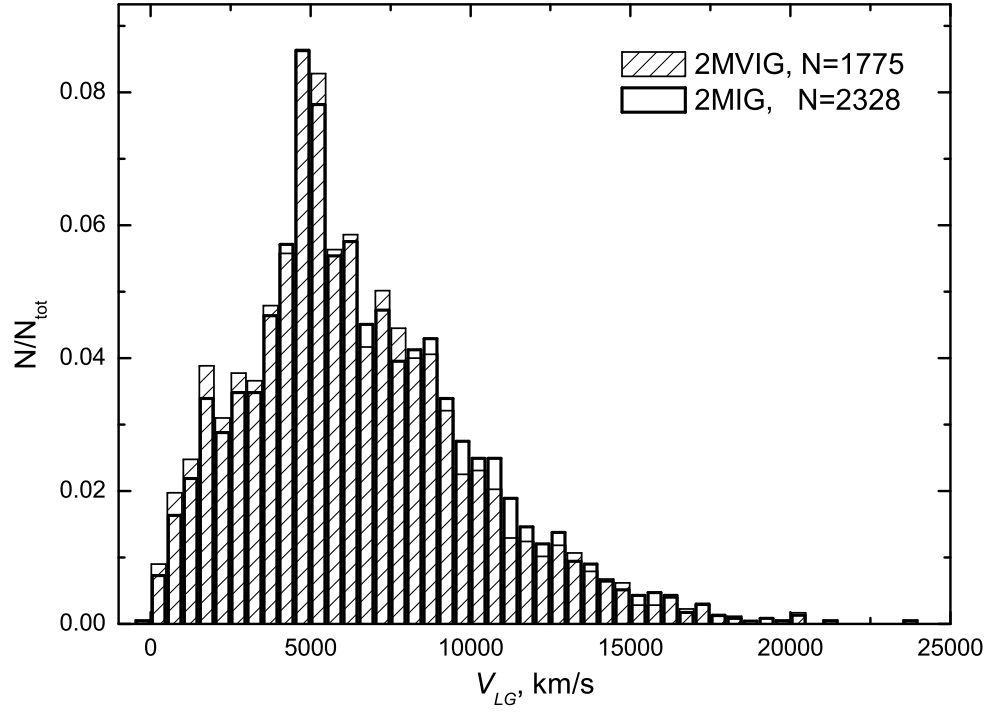


**Figure 9.** Celestial distribution of 3227 isolated galaxies in equatorial (the upper panel) and Galactic (the lower panel) coordinates.

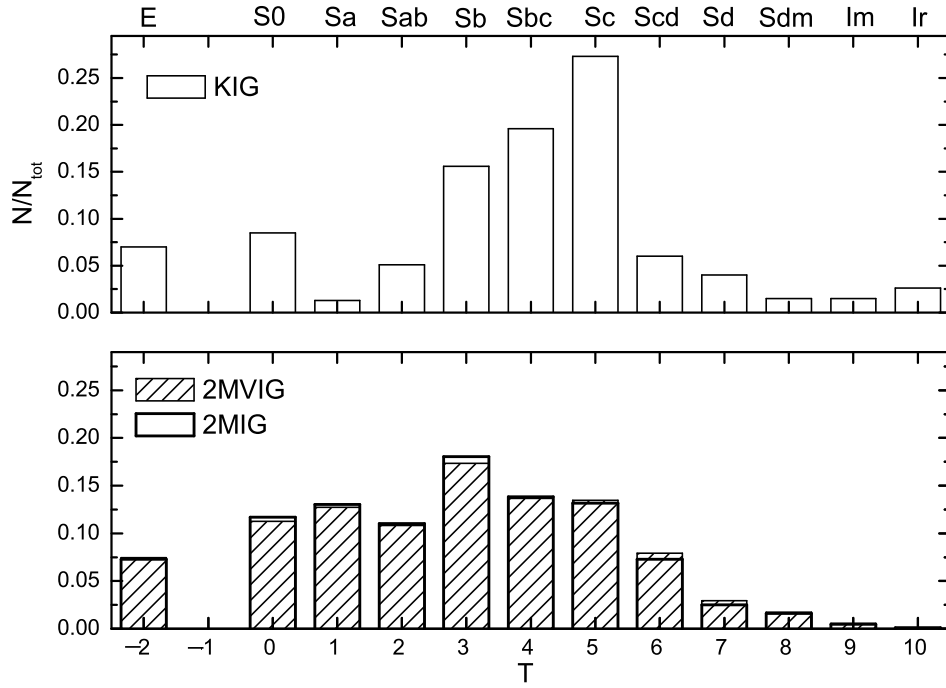
estimates. In 69% of the cases, the estimates differ by no more than one subtype. However, large discrepancies occur for some galaxies. Significant differences between morphological type estimates were found, e.g., in cases where a regularly shaped blue compact galaxy was mistaken for an elliptical galaxy. The availability of in-

frared images for all 2MIG-galaxies allowed us to distinguish BCG and E-galaxies with more confidence.

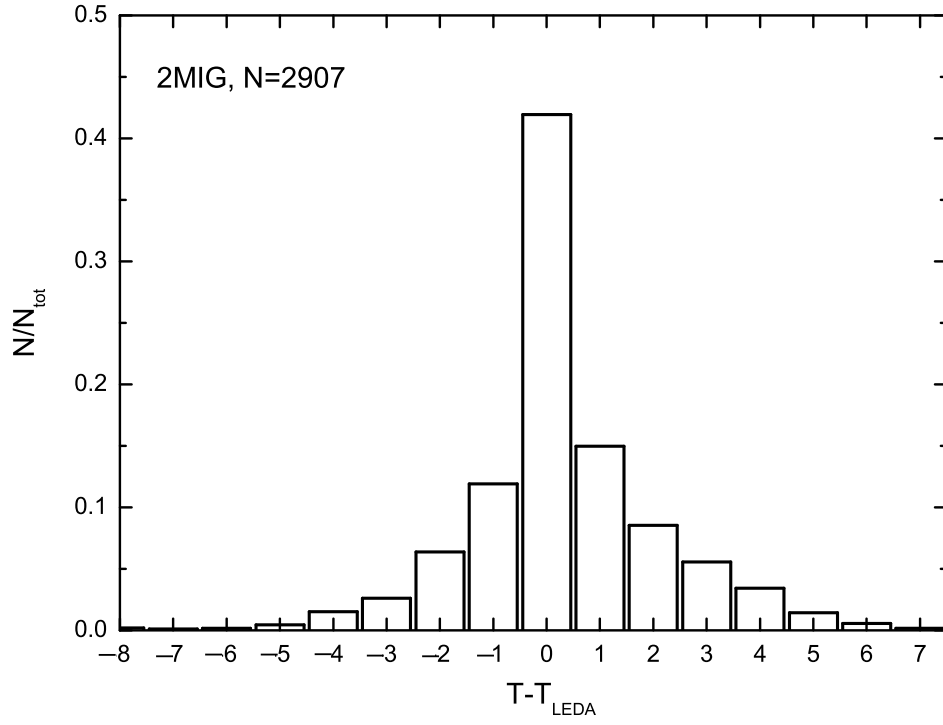
The above occurrence rates of different galaxy types in both 2MIG and KIG refer to catalog samples. The corresponding frequencies for a fixed volume may differ from the above values



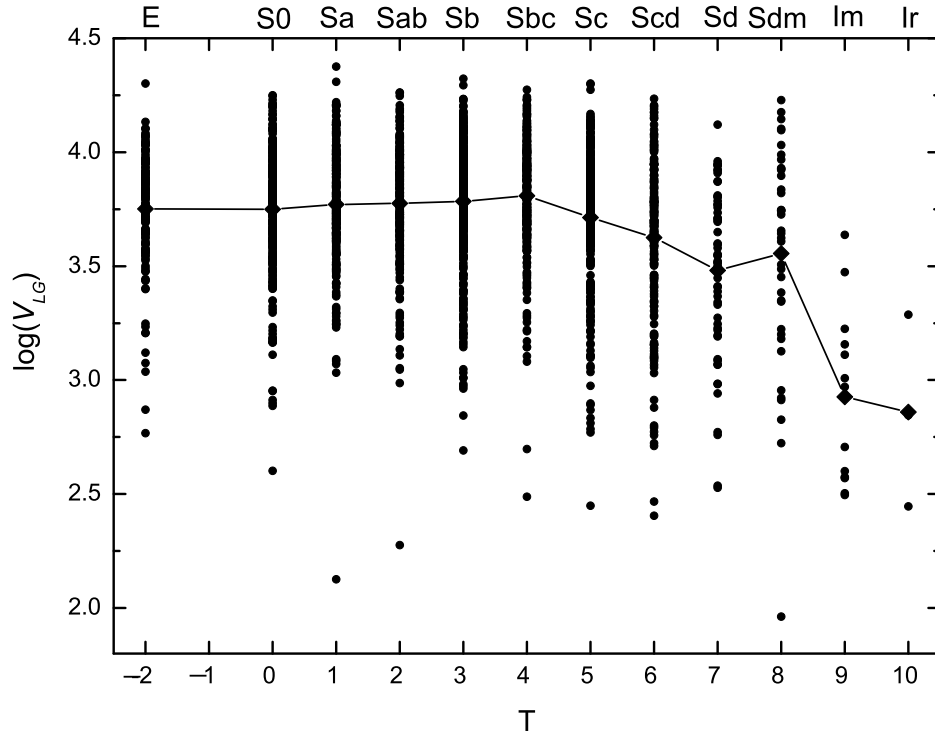
**Figure 10.** Distribution of radial velocities  $V_{LG}$  of the 2MIG and 2MVIG galaxies.



**Figure 11.** Distribution of morphological types of isolated galaxies: KIG galaxies from [16] and 2MIG galaxies.



**Figure 12.** Comparison of morphological type estimates for 2MIG galaxies obtained in this paper with those listed in the LEDA database.



**Figure 13.** The "radial velocity-morphological type" relation. The line connects the median radial velocity values for each type.

since galaxies of different types have different luminosities. Figure 13 demonstrates the relation between the radial velocities of 2MIG-galaxies and their morphological type. It is evident from this figure that the median radial velocity remains the same—about 5600 km/s for the galaxies of types spanning from E to Sc, and decreases towards later types: the median radial velocity for Im and Ir galaxies is as low as 800 km/s. This radial velocity trend reflects the variation of average infrared luminosity along the morphological type sequence. The volume occupied by the catalogued irregular galaxies is about 300 times smaller than the volume occupied by E–Sc-type galaxies and therefore the occurrence frequency of the former in the unit volume must be much higher than their occurrence frequency in the catalog. The data from the new catalog of isolated galaxies in the Local Supercluster [17] corroborate this evident conclusion. The fraction of irregular galaxies in this radial velocity limited sample of galaxies amounts to 30%.

## 6. CONCLUDING REMARKS

We undertook an automatic search for isolated galaxies among the extended sources of the Two Micron All Sky Survey (2MASS XSC) with  $K_s$  magnitudes in the interval  $4.0^m < K_s \leq 12.0^m$  and infrared angular diameters  $a_K \geq 30''$ .

To test the isolation of galaxies, we used more than one and a half million 2MASS XSC objects with apparent magnitudes  $K_s < 14^m.5$ . From the resulting sample of 4045 candidate isolated galaxies we excluded the objects that proved to be planetary nebulae or star clusters ( $N = 250$ ). Since the 2MASS survey is insensitive to blue low surface brightness galaxies, we inspected the neighborhood of each candidate galaxy on the POSS-I, POSS-II, and SDSS digital sky surveys. As a result, we found 2493 very isolated galaxies (the 2MVIG sample) that have no significant companions (according to Karachentseva’s criterion) neither in the infrared nor at optical wave-

lengths. The use of the available radial velocity data revealed a total of 567 galaxies that are not isolated, since they have significant neighbors or belong to groups. The remaining galaxies without radial velocity estimates ( $N = 734$ ) along with the 2MVIG sample made up the combined catalog of isolated galaxies (2MIG) containing a total of  $N = 3227$  objects.

The celestial distribution of 2MIG galaxies appears to be quite uniform without appreciable excess or deficit of galaxies in the regions of nearby clusters and groups. Isolated galaxies of our catalog account for 6% objects among the galaxies brighter than  $K_s = 12^m.0$  with diameters  $a_K \geq 30''$ , and the fraction of 2MIG galaxies is about the same both among bright and faint (distant) galaxies. The mean radial velocity of isolated galaxies is equal to 6500 km/s, making the 2MIG sample comparable in depth with the Catalog of isolated galaxies (KIG) [1]. The fraction of isolated E and S0 galaxies in the new catalog (19%) is almost the same as in the KIG, whereas the fraction of late-type spirals and irregulars in the 2MIG catalog is much less than in the KIG.

The catalog reported in this paper can be viewed as a homogeneous reference sample for further studies of the effects the environment imposes on the structure and evolution of galaxies.

**Table.** The 2MIG catalog of isolated galaxies

2MIG	RA, DEC (J2000)	Name	$r$	$K_s$	$2s$	$V_h$	T	N	Comments
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	00002508+0751138	UGC12892	23.7	11.12	66		2		Bar, ring
2	00005858-3336429	ESO349-017	21.6	11.55	61	6909	5		Vc
3	00015230+4020109	UGC12917	20.9	11.62	95		3	2	Bar, ring
4	00020314-4521288	PGC130018	17.9	11.51	76	11639	3		
5	00030565-0154495	UGC00005	30.1	10.34	99	7296	4	1	Bar, HII, KIG1, IRAS
6	00034871-4337058	PGC262	18.8	11.73	74	9076	2		AM0001-435
7	00041078-1313190	PGC941042	17.2	11.89	63		3	2	
8	00050536-0705363	IC1528	41.4	10.39	94	3768	3	2	HII
9	00051322-1130093	IC1529	21.9	10.37	113	6751	0	2	Pec, ring
10	00054271-7542251	ESO028-009	26.6	11.07	106	6042	4	1	IRAS
11	00081466+0746487	UGC00067	32.1	10.40	78	11833	2		Ring
12	00083428-1056579	MCG-02-01-028	20.5	11.84	101	9109	2	1	Bar, ring
13	00083453-3351299	NGC0010	56	9.48	67	6806	3		Bar, IRAS, Vc
14	00084249+3726523	NGC0011	43	9.98	181	4390	1	2	IRAS
15	00085471+2349009	NGC0009	22.2	11.80	125	4527	3		Pec, HII, KIG6, IRAS
16	00090246+2137279	NGC0015	26.9	10.42	64	6330	1	1	
17	00090345-3254509	ESO349-033	26	10.99	61	6892	3	2	IRAS
18	00090421+1055081	UGC00081	29.3	10.72	76	6674	3	3	
19	00095654-2457472	NGC0024	83	9.22	147	554	5		IRAS
20	00101611+3206223	CGCG499-061	15.3	11.72	71	19372	3	1	
21	00110081-1249206	IC0002	20.3	11.24	80		2		IRAS
22	00110634+0240406	CGCG382-030	21.4	11.58	72	12760	4		Ring, KIG7
23	00140398-2310555	NGC0045	49.3	10.07	79	466	8		Bar, IRAS
24	00141284+2245591	CGCG478-044	16.4	11.02	80		1	1	
25	00144279-6019425	NGC0053	38.8	10.30	112	4572	2		Bar, ring
26	00145057-8659351	ESO002-006	31.7	9.92	167		-2		
27	00151647-5714412	ESO111-022	22	11.13	72	9800	3		Ring, Vc
28	00161479+1019565	UGC00151	23.9	10.36	84	5254	-2		KIG13
29	00165087-0516060	MCG-01-01-064	32.7	10.64	81	3943	1	1	Bar, LINER, HII, IRAS
30	00170507+4209410	UGC00158	19.1	11.69	65	5065	3		
31	00170970-0342489	MCG-01-01-067	19.8	10.83	67	10959	-2		
32	00175470-4755408	ESO194-001	20.6	11.87	67	11450	5	1	
33	00181211+1311321	MCG+02-01-031	24.2	10.99	92	4131	1		IRAS
34	00182395+4843543	UGC00171	21.5	10.54	62	5266	4		Pec, HII, IRAS
35	00194400-1407184	IC0009	15.3	11.36	87	12622	3	1	Ring, Sy2, HII, IRAS
36	00194874+2346214	IC1540	28.3	10.85	65	5827	3		Bar
37	00200006-0620013	MCG-01-02-001	24.2	11.38	73	3709	2		Bar, pec
38	00214374-6142399	ESO112-001	29.2	11.16	61		5		
39	00215111-0929321	MCG-02-02-005	20.8	11.37	113	6267	3	1	Ring, IRAS
40	00220122+4908003	CGCG549-038	23.5	10.95	74	5144	4		Pec, HII, IRAS
41	00223386-0829109	MCG-02-02-007	21.9	11.07	110	5692	4	1	
42	00231109-5937029	ESO111-026	17	11.36	102		2	1	
43	00233603+2051113	UGC00225	17	11.28	78		1	1	
44	00235461-3232103	NGC0101	32.9	10.77	122	3383	5		Bar, HII, IRAS
45	00243651-1357229	NGC0102	28.8	10.74	63	7332	0		Bar, ring
46	00245879+4339459	UGC00236	17.4	10.76	94	5104	-2		KIG20
47	00250335+3120411	UGC00238	33.9	10.57	78	6766	4	1	LINER, IRAS



Table. (Contd.)

2MIG	RA, DEC (J2000)	Name	$r$	$K_s$	$2s$	$V_h$	T	N	Comments
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
48	00252991+4555181	UGC00243	57.8	9.61	78	5076	3		IRAS, Vc
49	00260321-0720047	PGC172039	15.1	11.29	66	15888	0	1	
50	00261744-0429323	MCG-01-02-014	31.2	10.98	92	3983	2		Bar, pec, HII, IRAS
51	00262976-6003220	PGC127809	21.4	11.33	83	4749	3	1	AM0024-602, IRAS
52	00265513-4438186	ESO242-009	16.1	11.80	64		9	2	
53	00265761-5658408	NGC0119	27.3	10.00	71	7430	-2		
54	00272276+1050542	UGC00266	18.5	11.33	61		1	2	
55	00281783-0929343	MCG-02-02-020	18.8	11.91	61	16959	3		
56	00290063-0819062	MCG-02-02-025	15.2	11.24	68	6110	0		
57	00291681+5319125	PGC2437721	18.5	11.05	82		1		
58	00294166-5131145	ESO194-021	35.9	9.12	123	3496	-2		
59	00294368+2128365	IC1552	27.9	10.99	100	5600	5		KIG23, IRAS
60	00300543-6013492	PGC143541	18.8	11.36	81	11923	1		
61	00302865+0551405	CGCG409-021	19.4	11.10	64	7087	0		
62	00304038-2842454	ESO410-015	22.6	10.99	64	7307	1		Vc
63	00304382-5900258	ESO112-006	15.5	11.44	72	8642	2	1	IRAS
64	00313584+1436442	UGC00316	26	11.51	66	11432	6		Vc
65	00314682+6817323	PGC137056	16.4	11.69	62		5		
66	00324265-1119054	MCG-02-02-049	44.6	10.35	62	4031	5		IRAS
67	00331028-1308462	MCG-02-02-051	15.8	11.81	64	6179	4		Bar, ring, IRAS
68	00333080+2254100	CGCG479-039	15.8	11.48	98	4599	0		KIG27, IRAS
69	00342461+1216066	IC0031	32.4	10.37	79	9515	2	1	
70	00344675-0823473	NGC0157	95.5	7.68	65	1673	4		Bar, IRAS
71	00345798-5133233	PGC129232	20.6	11.85	71		4	2	
72	00360908+5522418	PGC137012	21.2	11.35	64		3		
73	00372152-1956032	NGC0171	64.5	9.39	62	3884	2		Bar, ring, VV791A, IRAS
74	00373987+1021287	IC0035	20	11.13	95	4587	6	2	KIG30
75	00375565+0454408	CGCG409-049	26.4	11.25	75	8489	5		IRAS, Vc
76	00375769+0838068	NGC0180	55.2	9.73	69	5279	4	1	Bar, IRAS
77	00382373+1502223	UGC00386	16.3	11.18	64	5376	1		MRK343, IRAS, Vc
78	00383973+1724113	UGC00393	19.2	11.38	91	5432	3		Vc
79	00391554-4304315	ESO242-023	34.3	10.72	67	4026	5		Pec, IRAS
80	00393031+2304220	CGCG479-053	16.6	11.55	60		2	1	
81	00393535-4717285	2MFGC472	15.7	11.86	82		3	1	
82	00403145-4559074	ESO242-024	31.3	10.39	99	3695	1		Bar, IRAS
83	00410364+3143576	UGC00433	50.8	10.22	89	4654	5		IRAS
84	00411934+6855542	PGC137148	15.6	11.80	98		3	1	
85	00432575-5010580	NGC0238	53.1	10.06	96	8614	3		Bar, ring, IRAS, Vc
86	00433238+1420334	NGC0234	34.4	9.62	151	4457	5	1	IRAS
87	00441293-1235316	MCG-02-03-004	20.3	11.15	84	6784	0	1	IRAS
88	00450202-6045373	ESO112-009	18.7	10.92	83	10500	0	1	
89	00454643-1535487	NGC0244	18	11.32	81	941	9		VV728
90	00471276+2908110	2MFGC00567	16.5	11.34	71	5706	2		IRAS, Vc
91	00475430+6807433	2MFGC574	37	10.86	96		5		
92	00480150+0817494	NGC0257	40.3	9.66	78	5276	4	1	IRAS
93	00484212-4040202	2MFGC00586	20.1	11.96	97	10038	5		
94	00484744-4609041	PGC130104	15.4	11.60	61	15860	0	1	

Table. (Contd.)

2MIG	RA, DEC (J2000)	Name	$r$	$K_s$	$2s$	$V_h$	T	N	Comments
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
95	00493452-4652279	ESO243-002	20.2	11.62	112	8886	5		Bar, IRAS
96	00493887+2255564	UGC00506	24.6	10.33	79	7462	-2		
97	00494975-3520031	ESO351-010	18.8	11.63	92		4	1	
98	00500923-1326404	PGC937908	16.9	11.67	93		1	2	
99	00500956-0511376	NGC0268	32	10.58	87	5477	4		
100	00501956+6702517	PGC2796450	22.3	10.64	92		0		
101	00502252+1142376	UGC00513	16.3	11.86	66	11901	3	1	
102	00513111-3739192	MCG-06-03-001	16.8	11.10	75	7005	0	1	
103	00521377+4419514	UGC00530	25.4	10.74	99	5331	1	1	
104	00533211-5806256	IC1597	21	11.93	67	5053	3	2	
105	00543974-6317016	ESO079-010	21.5	11.30	67	5662	5	2	Bar, pec, ring IRAS
106	00544282+2131215	IC1596	18.9	11.63	90	2675	3	1	KIG39

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